Madden-Julian Oscillation: Recent Evolution, Current Status and Predictions

Update prepared by
Climate Prediction Center / NCEP
March 31, 2008

Outline

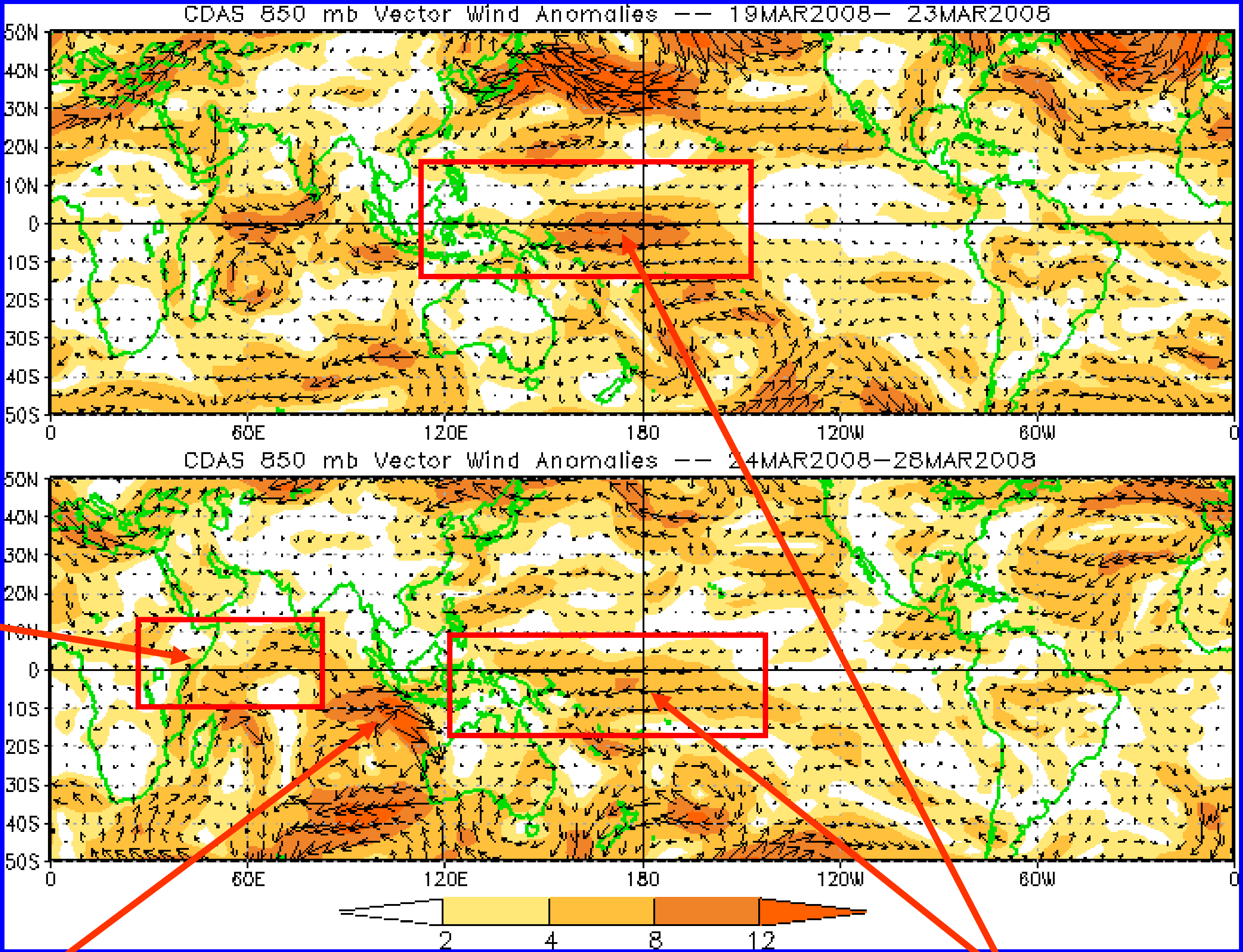
- Overview
- Recent Evolution and Current Conditions
- MJO Index Information
- MJO Index Forecasts
- MJO Composites

Overview

- Weak MJO activity continues with the convectively enhanced phase now located across the western Pacific and is rapidly entering the western hemisphere.
- The MJO is expected to remain weak during the next 1-2 weeks.
- Enhanced tropical rainfall is expected across parts of Indonesia and the South Pacific Convergence Zone mainly associated with La Nina. Dry conditions are anticipated for portions of southeast Africa and the Indian Ocean.

850-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the magnitude of anomalous wind vectors



Westerly anomalies across the western Indian Ocean have weakened during the last five days.

Strong westerly anomalies developed in southern tropical Indian Ocean – in part associated with tropical cyclone activity.

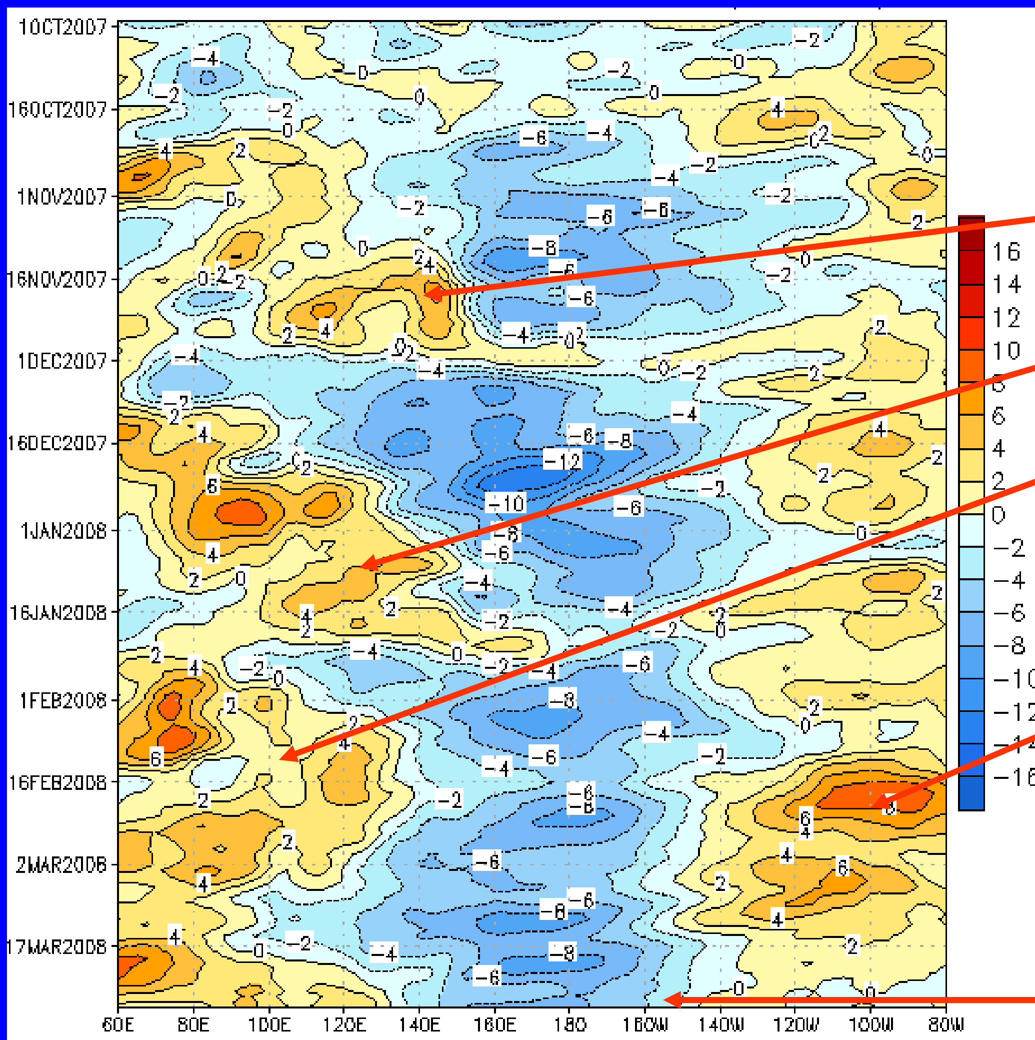
Easterly anomalies across the western Pacific have decreased during the last five days.

850-hPa Zonal Wind Anomalies (m s^{-1})

Westerly anomalies (orange/red shading) represent anomalous west-to-east flow

Easterly anomalies (blue shading) represent anomalous east-to-west flow

Time



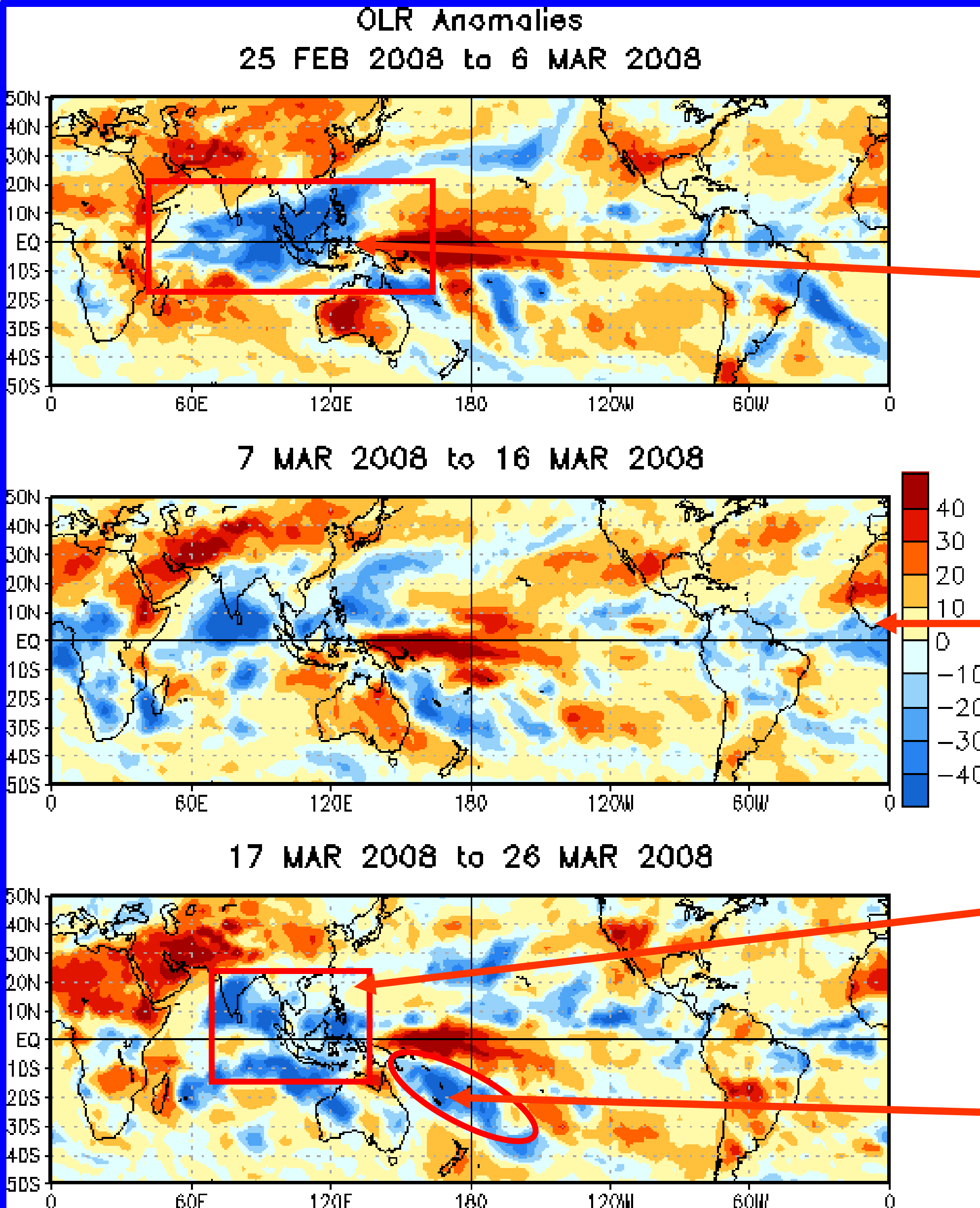
Longitude

Moderate-to-strong MJO activity was evident from late October to mid-late February as shown by westerly anomalies shifting eastward from the Indian Ocean across Indonesia and a weakening of the easterlies at the Date Line during early December, mid-January and mid-February.

Westerly anomalies increased during mid-February across the eastern Pacific.

Recently, westerly anomalies have shifted eastward to Indonesia. Low-level easterlies remain entrenched across much of the west-central Pacific.

OLR Anomalies: Last 30 days



Drier-than-normal conditions, positive OLR anomalies (red shading)

Wetter-than-normal conditions, negative OLR anomalies (blue shading)

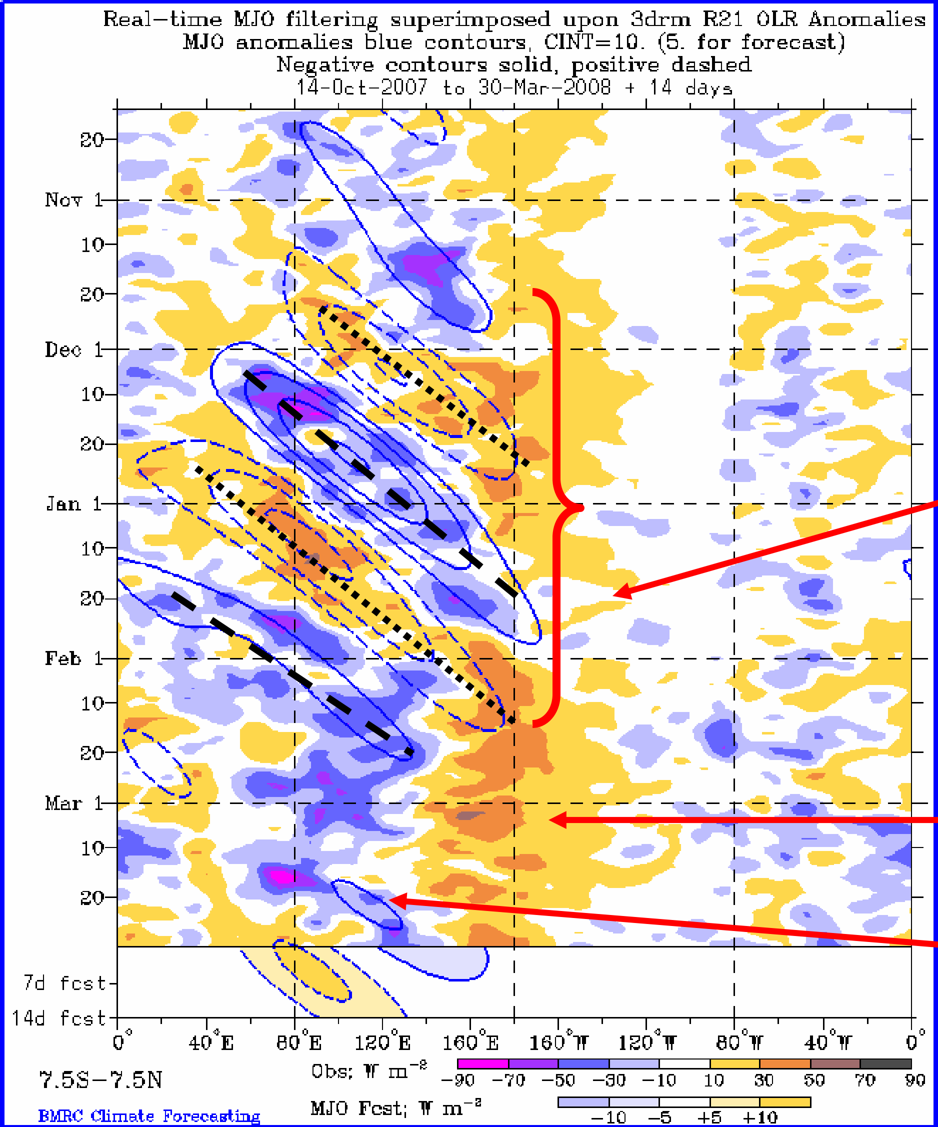
Wet conditions were observed across the Indian Ocean, Maritime Continent, and northern Australia during late February and early March.

During early-mid March, convection increased across parts of South America, the Atlantic Ocean, and Africa.

During late March, enhanced convection developed across the Maritime continent associated with the recent MJO activity.

Associated with La Nina, the South Pacific Convergence Zone (SPCZ) remains convectively active.

Outgoing Longwave Radiation (OLR) Anomalies (7.5°S-7.5°N)



Time

Longitude

Drier-than-normal conditions, positive OLR anomalies (yellow shading)

Wetter-than-normal conditions, negative OLR anomalies (blue shading)

(Courtesy of the Bureau of Meteorology Research Centre - Australia)

Moderate-to-strong MJO activity was evident from mid-November to mid-February with coherent eastward propagation of enhanced (suppressed) convection indicated by the dashed (dotted) lines.

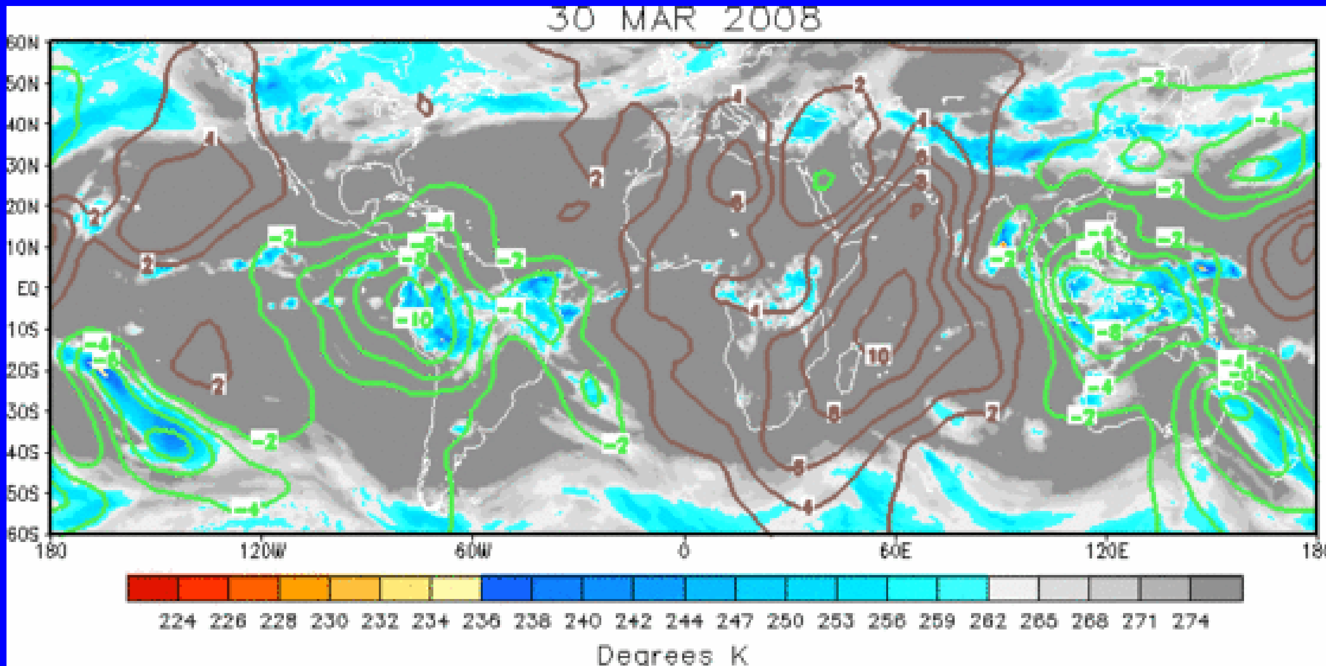
From mid-February to early-mid March, a more stationary pattern of anomalous convection was evident.

Enhanced convection across the Indian Ocean rapidly shifted east during mid-late March.

IR Temperatures (K) / 200-hPa Velocity Potential Anomalies

Positive anomalies (brown contours) indicate unfavorable conditions for precipitation

Negative anomalies (green contours) indicate favorable conditions for precipitation



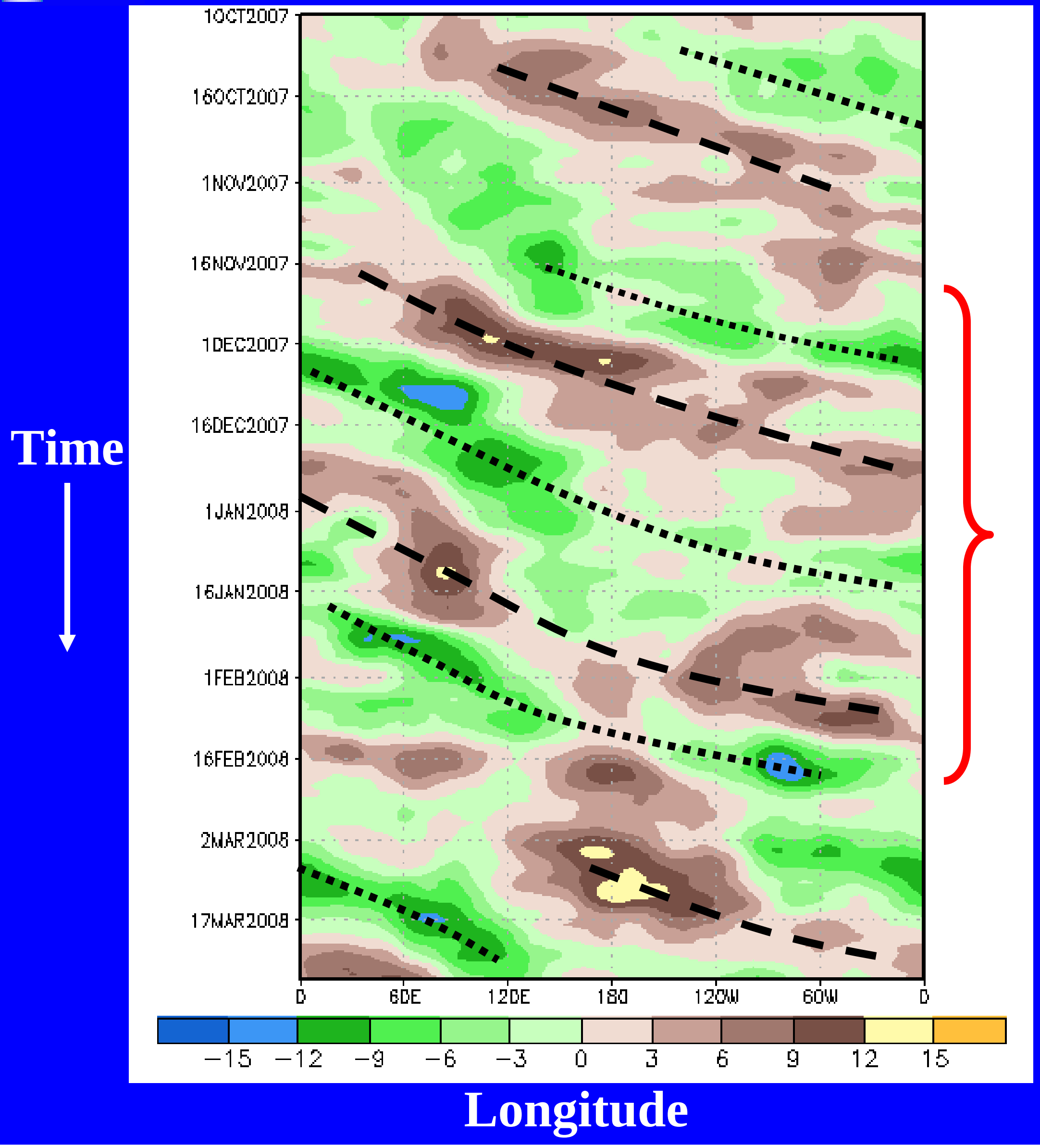
The current global velocity potential anomalies indicate a somewhat less coherent pattern.

Upper-level divergence is indicated across the Maritime Continent, the South Pacific Convergence Zone (SPCZ) and parts of South America while upper-level convergence prevails across the Atlantic Ocean, Africa, and western Indian Ocean.

200-hPa Velocity Potential Anomalies (5°S-5°N)

Positive anomalies (brown shading) indicate unfavorable conditions for precipitation

Negative anomalies (green shading) indicate favorable conditions for precipitation



The MJO strengthened during October but coherent propagation was generally short-lived.

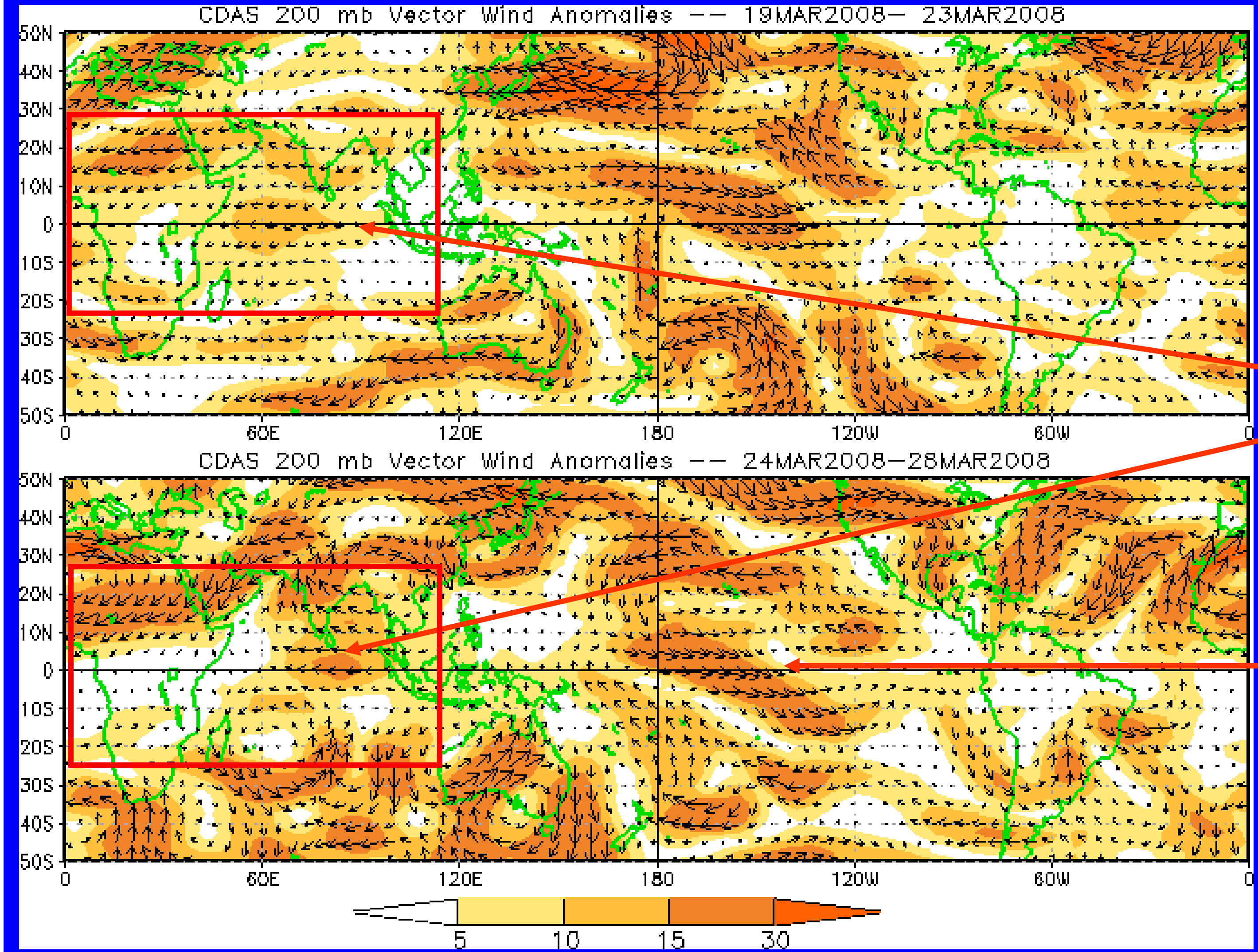
Moderate-to-strong MJO activity developed in mid-November and continued into mid-February.

The MJO weakened during the second half of February.

During early-mid March, velocity potential anomalies increased and some eastward propagation is evident.

200-hPa Vector Wind Anomalies (m s^{-1})

Note that shading denotes the magnitude of anomalous wind vectors



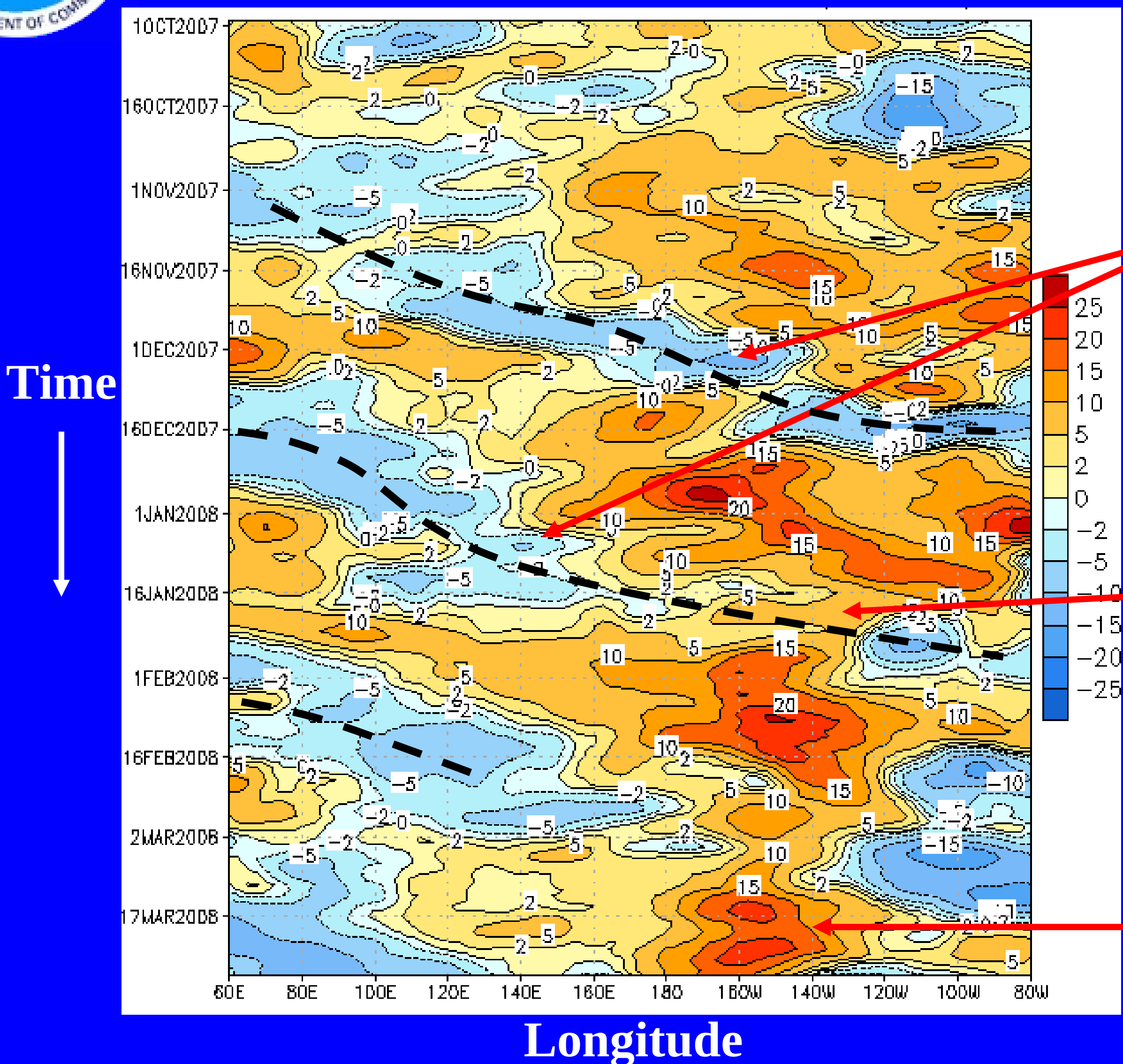
Easterly anomalies across the eastern hemisphere are less organized during the last five days.

Westerly anomalies continue across parts of the equatorial Pacific.

200-hPa Zonal Wind Anomalies (m s^{-1})

Westerly anomalies (orange/red shading) represent anomalous west-to-east flow

Easterly anomalies (blue shading) represent anomalous east-to-west flow



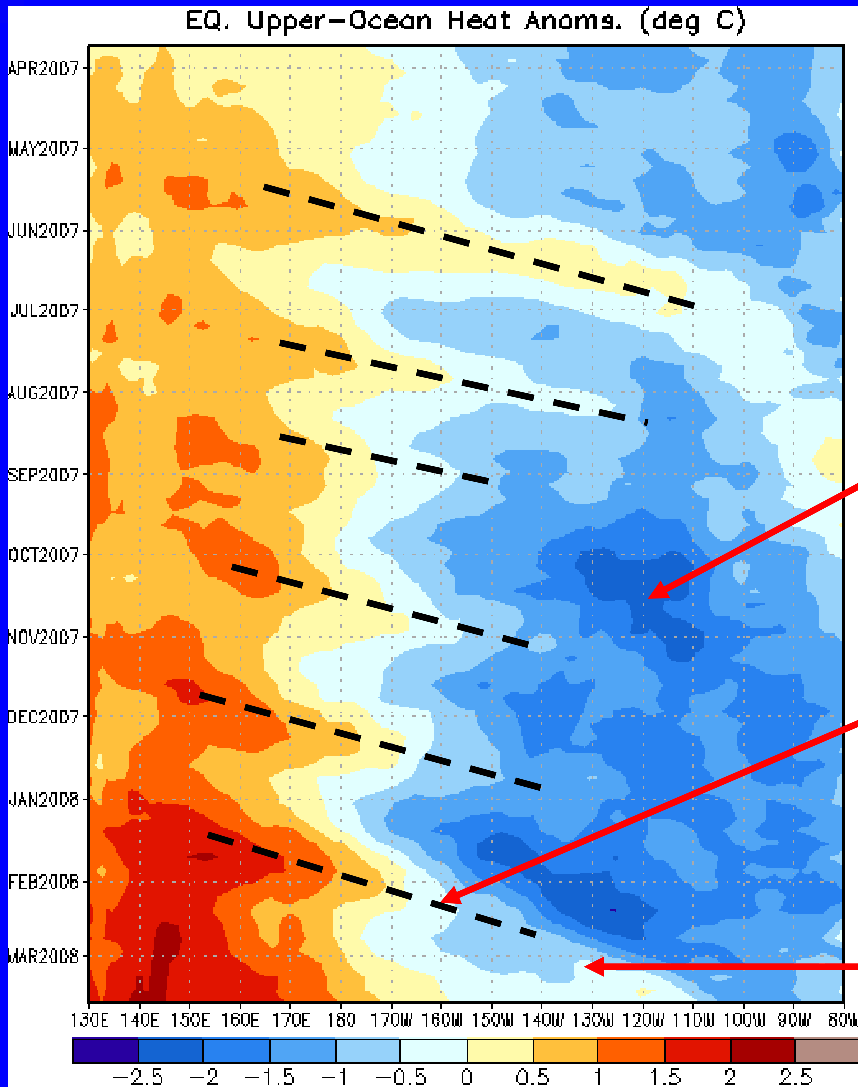
MJO activity is evident in the upper-levels by eastward propagation of easterly anomalies (dashed lines) globally from early November into February.

The signal of cycle 2 of this MJO activity was somewhat weaker and less distinct across the central Pacific Ocean during mid-January a result of strong La Nina conditions.

Most recently, westerly anomalies have increased from the Date Line to 120 °W in part due to a contribution from the most recent MJO activity.

Weekly Heat Content Evolution in the Equatorial Pacific

Time



Longitude

Kelvin wave activity (downwelling phases indicated by dashed lines) has been observed since May and has affected the sub-surface temperature departures at varying degrees across the Pacific Ocean. The strongest wave occurred during May and June.

During September and October, negative heat content anomalies increased markedly across the eastern Pacific Ocean.

From late January into early February, increasingly positive anomalies developed across the western Pacific and shifted eastward associated with the latest downwelling Kelvin wave.

Negative anomalies have decreased during the last few weeks across the central Pacific.

MJO Index -- Information

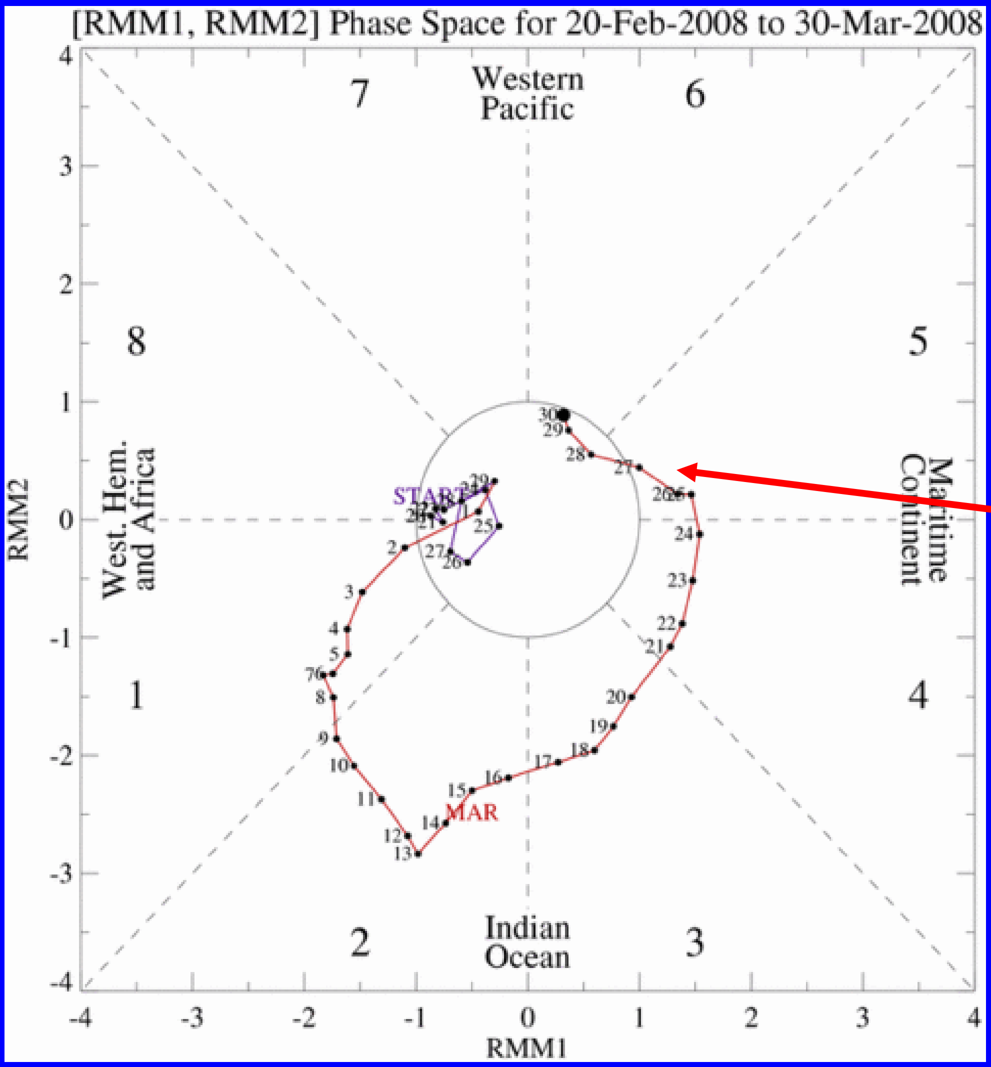
- The MJO index illustrated on the next several slides is the CPC version of the Wheeler and Hendon index (2004, hereafter WH2004).

Wheeler M. and H. Hendon, 2004: An All-Season Real-Time Multivariate MJO Index: Development of an Index for Monitoring and Prediction, *Monthly Weather Review,* 132, 1917-1932.

- The methodology is nearly identical to that described in WH2004 but small deviations from the BMRC figure are possible at times due to differences in input data and methodology. These typically occur during weak MJO periods.

- The index is based on a combined Empirical Orthogonal Function (EOF) analysis using fields of near-equatorially-averaged 850-hPa and 200-hPa zonal wind and outgoing longwave radiation (OLR).

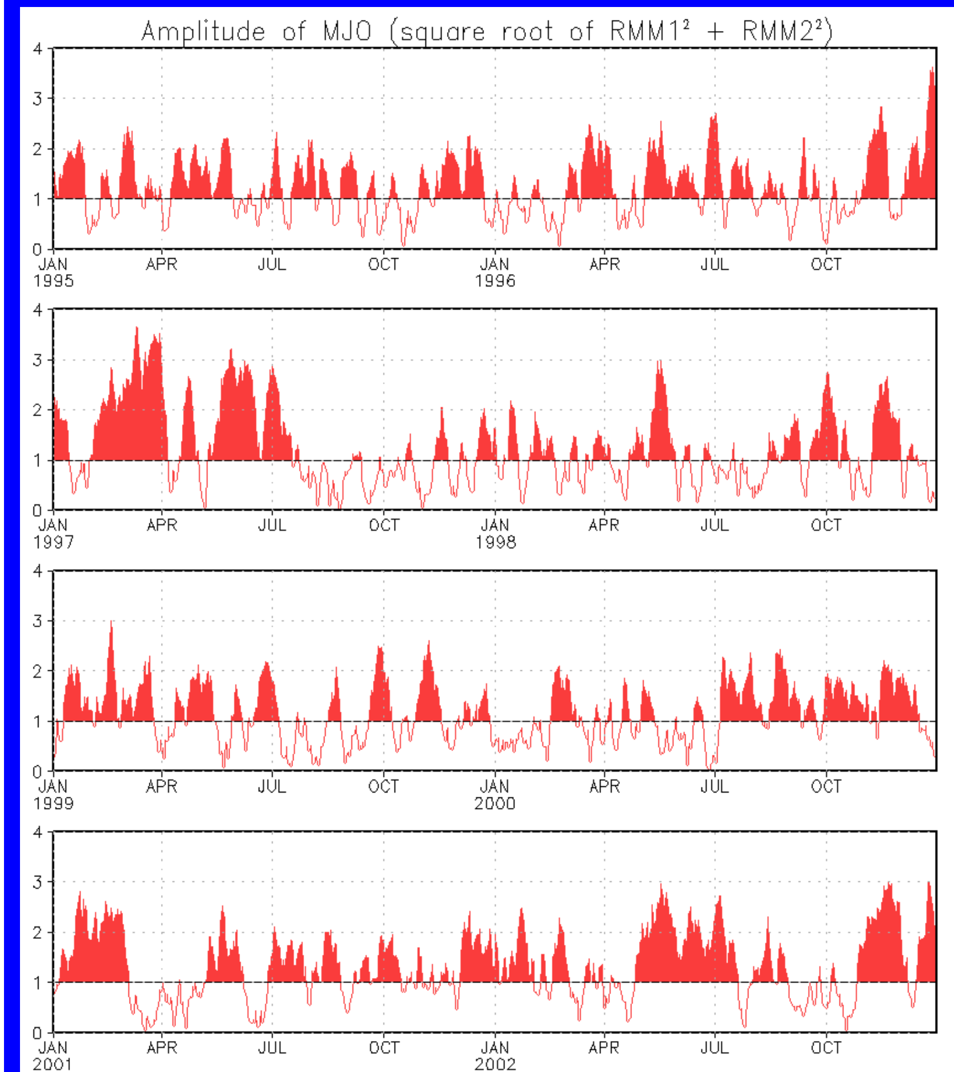
MJO Index -- Recent Evolution

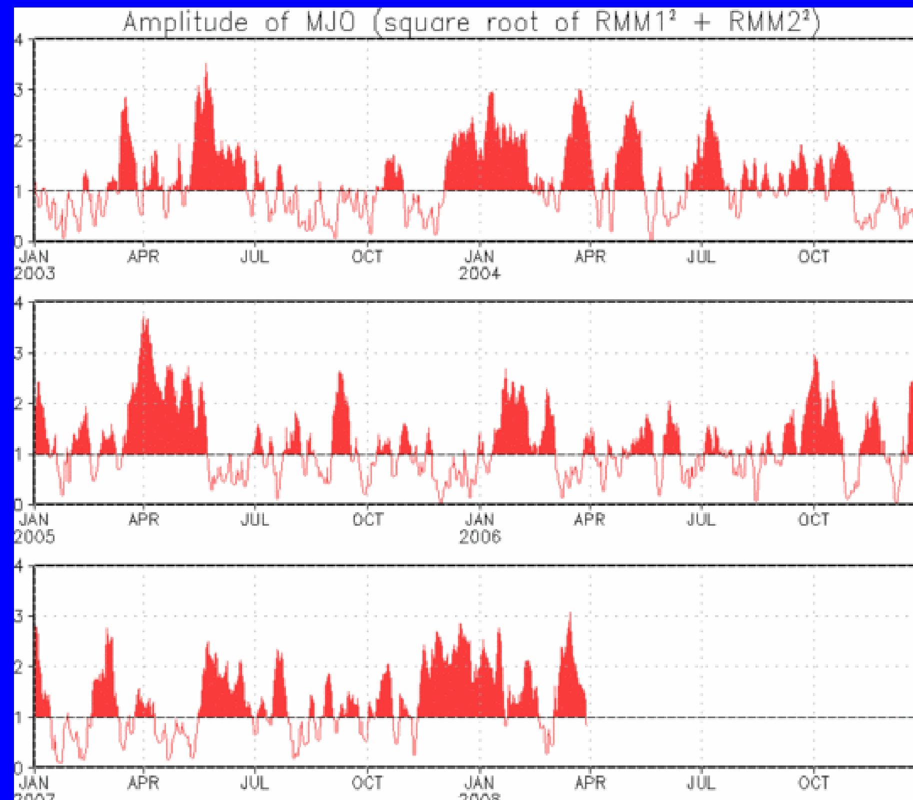


- The axes (RMM1 and RMM2) represent daily values of the principal components from the two leading modes
- The triangular areas indicate the location of the enhanced phase of the MJO
- Counter-clockwise motion is indicative of eastward propagation
- Distance from the origin is proportional to MJO strength
- Line colors distinguish different months

The MJO signal has decreased during the past week but a continued eastward propagation is evident.

MJO Index – Historical Daily Time Series





Time series of daily MJO index amplitude from 1995 to present

Plots put current MJO activity in historical context

Ensemble GFS MJO Forecasts

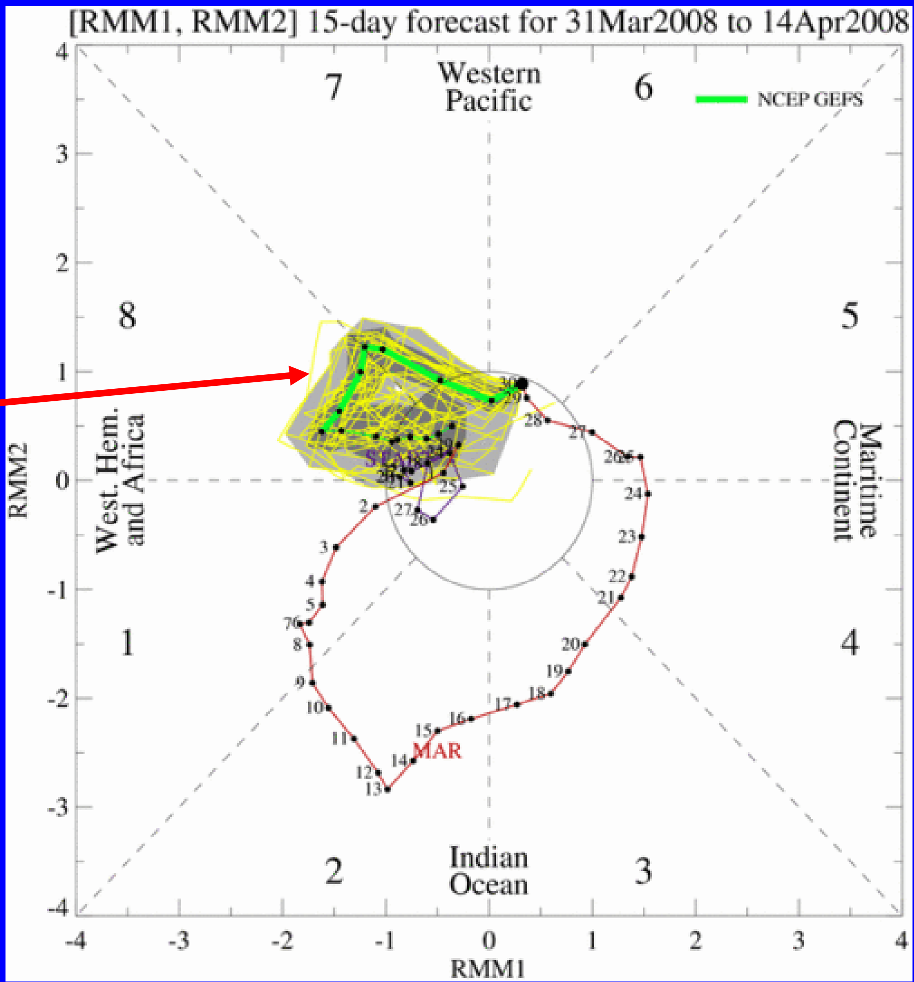
Yellow Lines – 20 Individual Members
Green Line – Ensemble Mean

RMM1 and RMM2 values for the most recent 40 days and forecasts from the ensemble Global Forecast System (GEFS) for the next 15 days

light gray shading: 90% of forecasts
dark gray shading: 50% of forecasts

The GFS ensemble mean predicts a weak MJO signal during the next week with initial fast eastward propagation into the western hemisphere.

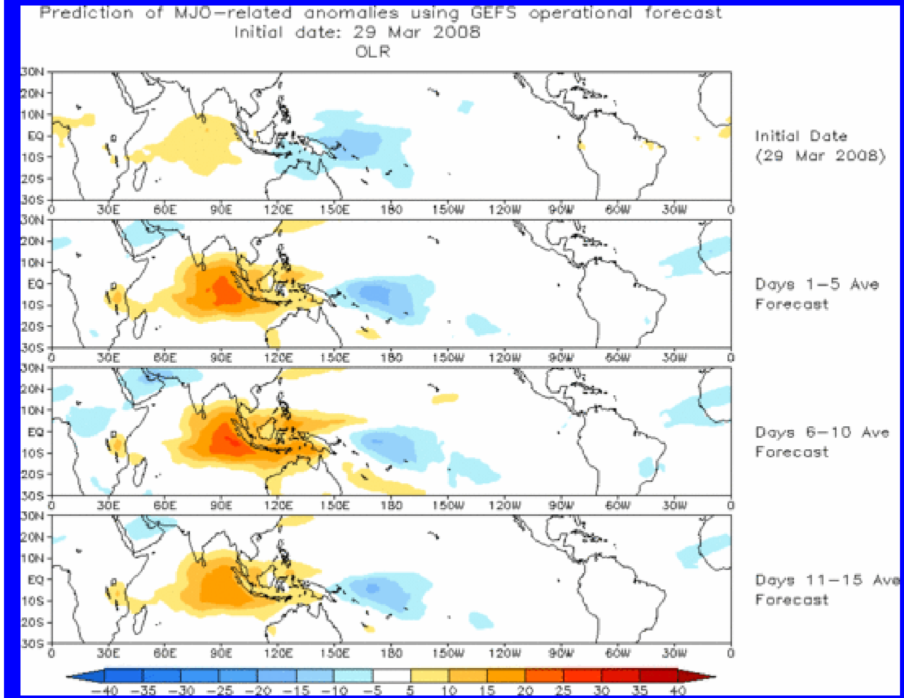
Considerable uncertainty exists for the future evolution of the MJO during week 2.



Ensemble Mean GFS MJO Forecast

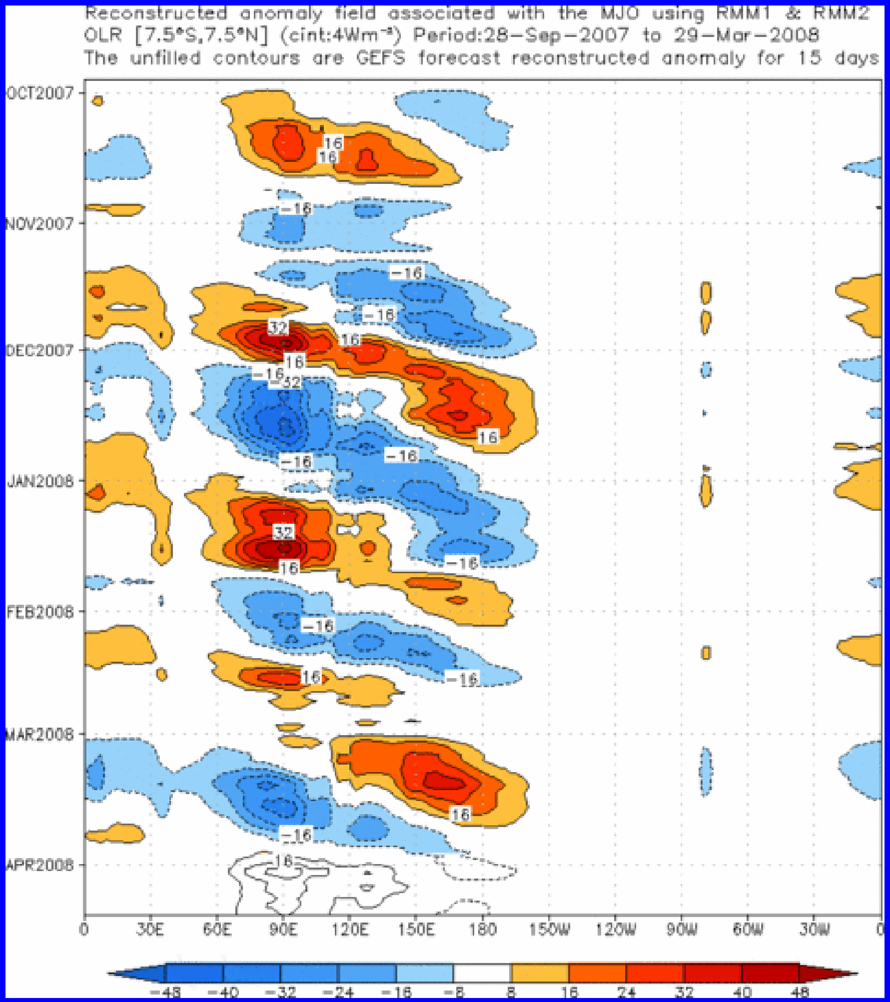
Figures below show MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies for the next 15 days



MJO-related enhanced convection is forecast to shift some from Indonesia to the southwest Pacific. Suppressed convection, associated with the MJO only, is forecast for the Maritime continent.

Time-longitude section of (7.5°S-7.5°N) OLR anomalies for the last 180 days and for the next 15 days



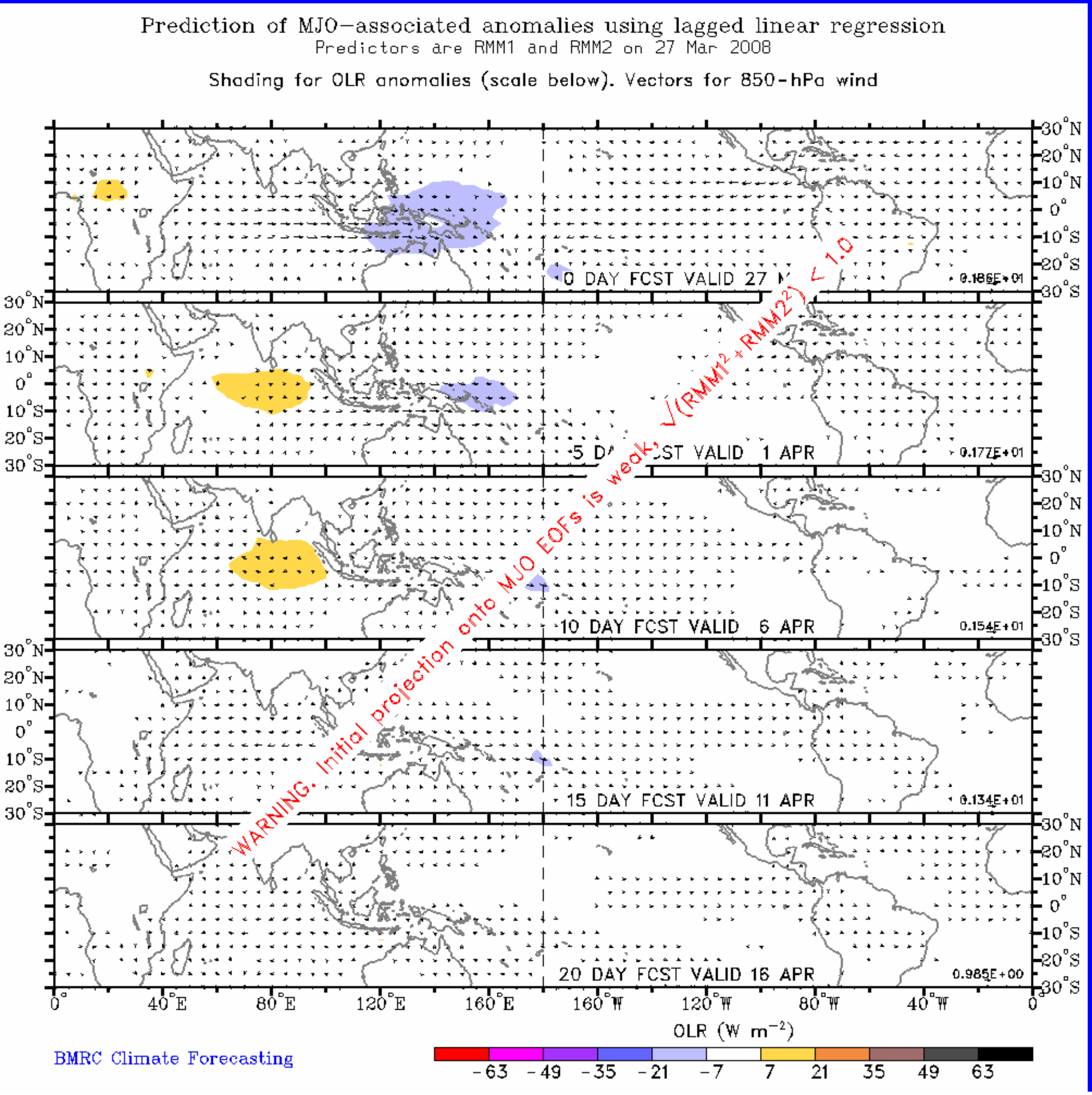
Statistical MJO Forecast

Figure below shows MJO associated OLR anomalies only (reconstructed from RMM1 and RMM2) and do not include contributions from other modes (*i.e.*, ENSO, monsoons)

Spatial map of OLR anomalies and 850-hPa wind vectors for the next 20 days

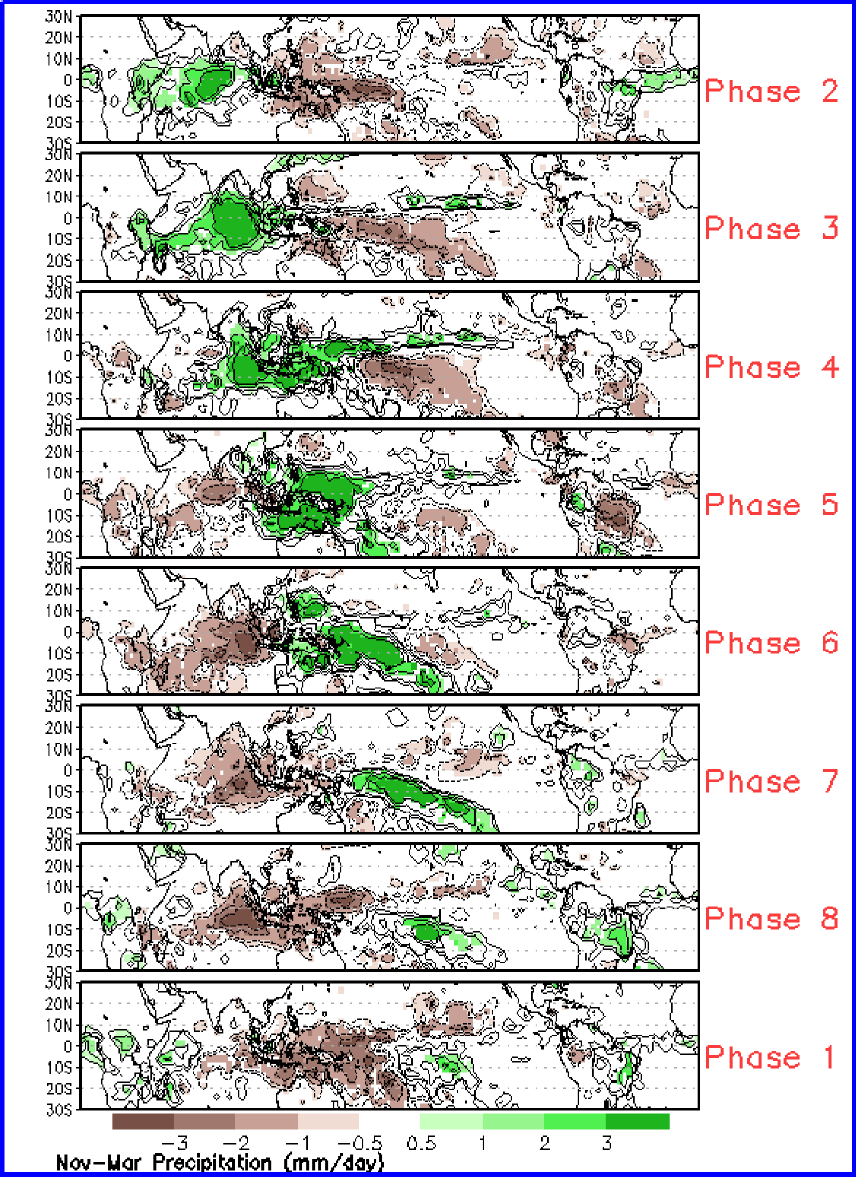
(Courtesy of the Bureau of Meteorology Research Centre - Australia)

The statistical method forecasts weak MJO activity during the next 1-2 weeks.



MJO Composites – Global Tropics

Precipitation Anomalies



850-hPa Wind Anomalies